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MUNICIPAL AND INDUSTRIAL WATER RE-
QUIREMENTS, MARION AND CEDAR POINT
RESERVOIRS, COTTONWOOD RIVER, KANSAS

Public Health Service
Dallas, Texas

July 1961

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MUNICIPAL AND INDUSTRIAL WATER REQUIREMENTS

MARION AND CEDAR POINT RESERVOIRS

COTTONWOOD RIVER

KANSAS

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Region VII
Dallas, Texas

In Cooperation with the

DEPARTMENT OF THE ARMY
U. S. Army Engineer District - Tulsa, Oklahoma

JULY 1961

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I. INTRODUCTION

Authority

This report was prepared at the request of the District Engineer, Tulsa District, Corps of Engineers. It was authorized by a Memorandum of Agreement between the Departments of the Army and Health, Education, and Welfare, dated November 4, 1958. The Memorandum established the working arrangements between the Public Health Service and the Corps of Engineers in regard to the Water Supply Act of 1958.

Purpose and Scope

The primary purpose of the study was to determine the needs for, and value of, storage in the proposed Marion and Cedar Point Reservoirs for municipal and industrial water supply. Related aspects are investigation of the suitability of the water for general municipal and industrial use, and a review of previous studies concerning low-flow augmentation for stream quality preservation in the Cottonwood and Neosho Rivers.

An economic-demographic analysis has been made for the study area. This analysis, together with a study of present and expected future patterns of water use, is the basis for an estimate of future water demands, projected to the year 2015.

Acknowledgments

The cooperation and assistance of many persons and agencies are gratefully acknowledged. Special appreciation is expressed to the following:

Kansas State Board of Health
Kansas Water Resources Board
Kansas Industrial Development Commission
City officials, Hillsboro, Marion, and Emporia, Kansas
Black and Veatch, Consulting Engineers, Kansas City,
Missouri

II. SUMMARY AND CONCLUSIONS

Summary

1. The Marion and Cedar Point Reservoir sites are in the upper reaches of the Cottonwood River watershed, a tributary of the Grand-Neosho River system.
2. The study area consists of the cities of Emporia, Marion, Hillsboro, and other communities located on, or close to, the Cottonwood River, in Marion, Chase, and Lyon Counties, Kansas.
3. Authorized conservation storage in the two projects could provide an estimated dependable flow of 17 cfs (cubic feet per second) in the Cottonwood River. There is a possibility that this flow rate could be increased to 23 cfs by enlargement of the proposed Marion Reservoir.
4. Previous studies by the Public Health Service have indicated a need for storage on the Neosho and Cottonwood Rivers to maintain a flow of about 50 cfs at Emporia. Of this requirement, about 14 cfs can be provided by existing and currently planned projects other than Marion and Cedar Point Reservoirs.
5. A program of water sample collection and analysis should be initiated on each stream, near the proposed dam sites, to provide needed information as to the quality of stored water.

Conclusions

1. It is recommended that the maximum economically feasible amount of conservation storage be included in each of the two reservoirs. Releases from storage would serve the dual purposes of water supply and stream quality preservation.
2. The annual value of storage for these purposes is \$13,760 per cfs of yield at Emporia. This is equivalent to a value of \$233,900 per year for a yield of 17 cfs, or \$316,500 per year for a yield of 23 cfs. These values are based on an analysis of alternatives and costs, as presented in detail in a previous report. 6/

III. DESCRIPTION OF PROJECTS

Location

The Cottonwood River originates in the eastern part of McPherson County, Kansas, and flows in a southeasterly direction about 50 miles to the vicinity of Florence, Kansas, and thence in a generally easterly direction to its confluence with the Neosho River, about six miles east of Emporia, Kansas. The Marion dam site is on the Cottonwood River about three miles from the city of Marion, Kansas, 127 river miles above the mouth of the river (see Figure 1).

Cedar Creek, a principal tributary of the Cottonwood River, has its source in Chase County, Kansas, and flows westerly and northerly about 26 miles to join the Cottonwood River at mile 94, about one mile east of Cedar Point, Kansas. The Cedar Point dam site is on Cedar Creek about four miles above its mouth. ^{1/}

Pertinent Data

Average annual runoff at the Marion dam site has been estimated by the Corps of Engineers at 50,160 acre-feet, or 69 cfs (cubic feet per second), from a drainage area of 200 square miles. Average flow in Cedar Creek is 51 cfs, as measured by U. S. Geological Survey at a gaging station near the Cedar Point dam site, for the 21-year period from 1938 to 1959. ^{2/} Drainage area at Cedar Point dam is 121 square miles. Periods of zero flow have been experienced periodically at both dam sites.

Both projects have been authorized by Congress, in the Flood Control Act approved May 17, 1950. As reported in the authorization document, ^{1/} Marion Reservoir would have a total capacity of 90,000 acre-feet, of which 60,000 is allocated to flood control and 2,500 is sedimentation reserve. The remaining 27,500 acre-feet was allocated to low-flow augmentation. More recently, the Corps of Engineers has increased the sediment reserve pool to 4,700 acre-feet and reduced the low-flow control storage correspondingly to 25,300 acre-feet. ^{3/}

The Corps of Engineers has further advised by letter dated 28 June 1960, that it would be physically possible to include approximately 35,000 acre-feet of additional storage, by enlarging the reservoir. The yield from the additional storage is estimated at four mgd (million gallons daily) over and above the yield from authorized storage. The cited letter, and subsequent discussions with Corps officials, suggest that such an enlargement of the reservoir would be quite costly, and might not be practical. Nevertheless, a value of the additional storage is included in this report for purposes of economic analysis, because the study indicates a need for the water.

III-1-a

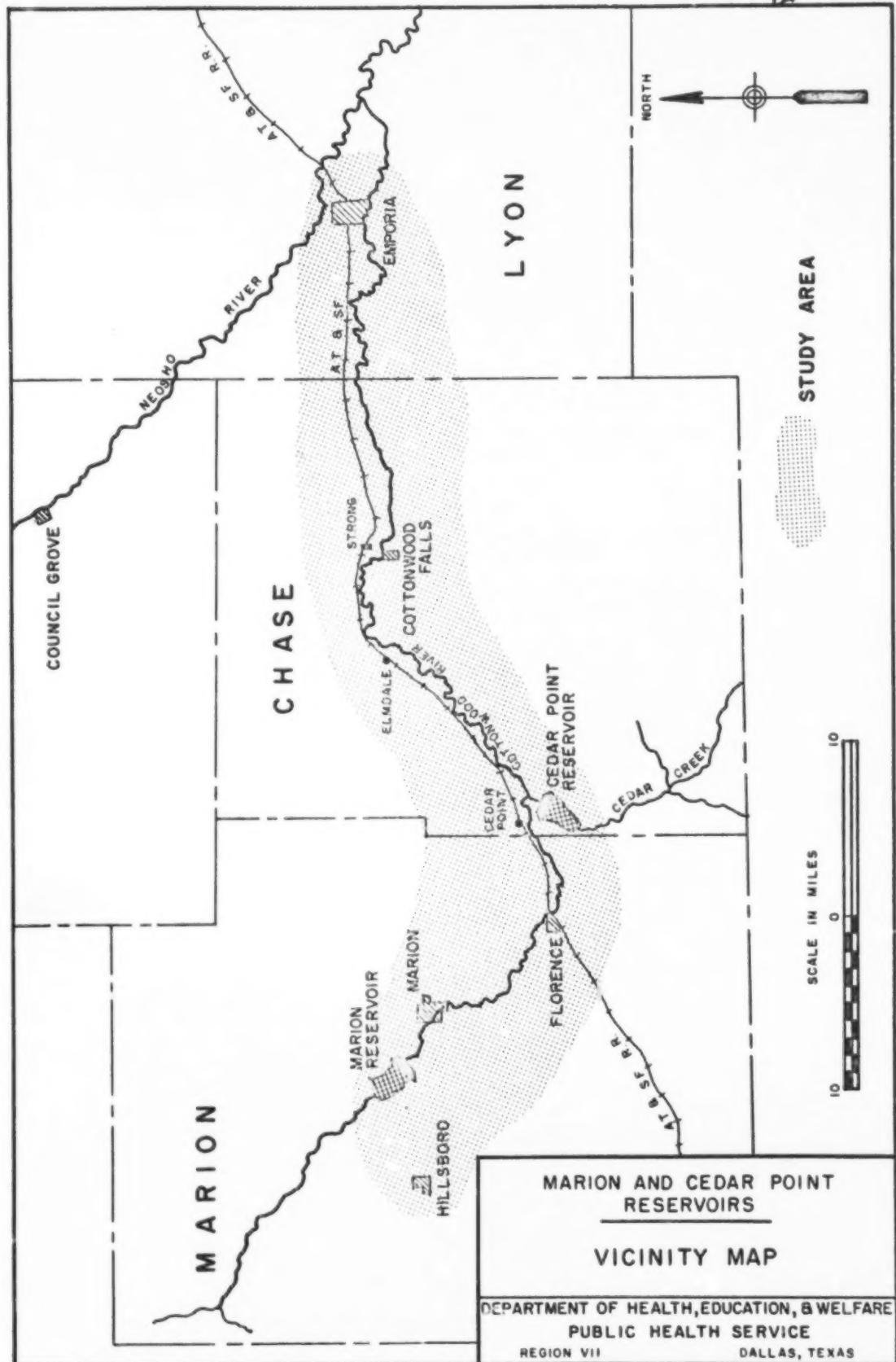


FIGURE 1

Authorized storage in Cedar Point Reservoir is 55,000 acre-feet, allocated as follows: 36,200 acre-feet to flood control, 1,800 to sediment reserve, and 17,000 to low-flow augmentation.

The latest hydrologic studies of the Corps of Engineers indicate that the combined authorized storage in Marion and Cedar Point Reservoirs would provide a firm flow of about 17 cfs on the Cottonwood River at Emporia. Adding to this the possible yield from enlargement of Marion of 6 cfs, the total to be evaluated in this report is combined storage which would assure a flow of 23 cfs in the Cottonwood River during the design drouth period.

Water Quality

The Kansas State Board of Health compiled and published, in 1960, all known records concerning chemical quality of surface waters in the Neosho River Basin. 4/ The general situation in regard to water quality is described by the following quotation from the Foreword to that publication.

"The surface waters of the Neosho River Basin are not highly mineralized in their natural state. There was a period of several years during the early development of oil wells in this area, that chloride pollution was a problem. Since that time, the general adoption of proper disposal methods for oil field beines has to a great extent corrected this situation, so that the chemical quality of water from all streams in the unit is now satisfactory. With adequate protection from pollution the water will remain usable at all locations."

That the statements quoted above are generally true of the Cottonwood River is evidenced by analyses of water samples at Emporia, Kansas, near the mouth of the river. Table 1 gives an abstract of chemical analyses of samples taken from the Emporia water intake. Limiting concentrations of applicable constituents, as recommended in Public Health Service Drinking Water Standards, 5/ are given in Table 1 for comparison.

Also shown in Table 1 are the analyses of two water samples taken from the Cottonwood River near Marion. These samples, analyzed in 1946 and 1955, constitute the only known records on which to judge the suitability of water to be stored in the proposed Marion Reservoir. The result of analysis of only two samples is inconclusive evidence, but a note of warning is sounded by the high concentration of sulfates (SO₄). Additional grounds for suspicion are furnished by the quality records of ground water at Hillsboro, Kansas.

Table 1

Chemical Analyses - Cottonwood River

Parts Per Million									
Date	Flow cfs	Total Dissolved Solids	Fe	Mn	Mg	SO ₄	Cl	Hardness	
								Total	Non- Carbon- ate
Cottonwood River at Emporia Water Intake:									
10-8-56		590	0.63	0.43	33	126	59	442	120
2-27-57		465	0.39	0.15	30	76	38	358	54
6-5-57	505	228	2.8 (?)	0.30	10	37	14	166	28
8-20-57	16	536	0.25	0.16	29	165	50	404	174
11-4-57		302	0.45	0.10	9	28	87	176	56
1-30-58		432			22	114	31	338	114
5-28-58		564			29	185	53	404	182
8-27-58		383			20	92	24	299	88
10-29-58		588			31	156	44	457	159
2-25-59		437			25	107	30	350	110
6-24-59		229			16	49	17	238	53
8-5-59		493			24	89	31	388	82
3-10-60		562			31	141	37	452	148
Cottonwood River at Marion:									
5-13-46	28	860	1.2	0.18	50	312	34	614	314
4-16-55		1,160	0.34	0.56	60	574	91	843	619
PHS Standard		500	(Fe + Mn: 0.3)		125	250	250	---	---

The shallow ground water aquifer at Hillsboro has sulfate concentrations ranging to more than a thousand parts per million. Detailed information on ground water hydrology in Marion County is not available. It is possible that ground waters from the aquifer supplying Hillsboro also contribute to base flow in the upper Cottonwood River; and, therefore, that sulfate concentrations higher than 250 ppm may be expected to prevail in the river.

The situation described in the foregoing calls attention to the impossibility of applying, to a small local watershed, the information on water quality obtained by sampling from the larger parent stream. Samples collected from the main stem reflect a composite of the quality of the runoff from the entire drainage area above the sampling point, and conclusions cannot safely be drawn from these data regarding water quality from small headwater areas or tributaries.

A supplementary sampling program in the vicinities of both Marion and Cedar Point dam sites is desirable. Collection and analysis of samples carried out over a period of time sufficient to define the range of variation in important constituents will aid in more clearly defining quality of water to be expected in these impoundments.

IV. DESCRIPTION OF STUDY AREA

Location

The study area consists of the cities of Emporia, Marion, Hillsboro, and several smaller communities located on, or close to, the Cottonwood River, in Marion, Chase, and Lyon Counties, Kansas. See Figure 1.

Preliminary consideration was given to a larger area and to more distant potential demand centers - notably Wichita, Kansas, which is about 50 miles southwest of the projects. It was decided that detailed analysis of a larger area was not warranted for this report, because the entire potential yield from the projects will be needed within the Cottonwood River valley and downstream. A study made by this office in 1960 6/ overlaps the current study in the city of Emporia, Kansas, and includes the area downstream on the Neosho River as far south as the Oklahoma State line.

In addition to local area studies such as the one reported herein, the Public Health Service is currently making a comprehensive regional water resources survey of the Arkansas River Basin. That study will encompass all of the local areas, and perhaps modify the conclusions of individual project investigations.

Geography

The study area is rolling prairie land ranging in elevation from 1,000 to 1,500 feet above sea level. Most of the land is devoted to crops or stock grazing, and there is very little timber.

Located at the geographical center of the country, the study area "...has a distinctly continental climate with characteristically changeable temperature and precipitation." 7/ Mean annual temperature is about 56 degrees, ranging from an average of 32 degrees in January to 80 degrees in July.

Normal precipitation, at Emporia, Kansas, is 34.95 inches per year. Within the past decade, precipitation at Emporia has varied from 13 inches below to 24 inches above normal, according to U. S. Weather Bureau records. "Distribution of rainfall through the year favors crop production, with an average of about 75 per cent of the year's total falling in the crop growing season, April to September." 7/

V. POPULATION PROJECTIONS

The Economic Situation

General

This section defines the past and present economy of the Marion-Cedar Point study area.

Statistical data have been compiled and abstracts are given herein for the tri-county area of Marion, Lyon, and Chase Counties, Kansas. These are generally indicative of the economic base for the demand area.

Population of the tri-county area has declined steadily since 1930, dropping from 56,931 in 1930 to 45,992 in 1960. Contrary to this downward trend, Emporia, the largest city, has shown a significant increase since 1940 and exhibits growth possibilities for the future. 8,9,10/

Agriculture

Rural population decreased from 30,377 in 1920 to 15,251 in 1960. A decrease of 40 per cent from 1940 to 1950 in agricultural employment has been largely responsible for the decline in population. The reduction in agricultural employment was brought about by adaptation to new techniques in farming. 8,9,10/

The agricultural economy of the tri-county area has prospered. For example, the value of crops sold increased 56 per cent (in constant dollars), from 1944 to 1954; during the same period, the U. S. average increase was 22 per cent. The tri-county value of livestock and livestock products sold during the period 1944 to 1954 increased 9 per cent, while the U. S. average increase was 13 per cent during this period.

Agricultural trends for the tri-county area are shown in Table 2.

Table 2

Agricultural Trends 11,12,13/

<u>Year</u>	<u>Number of Farms</u>	<u>Cropland Harvested (Acres)</u>	<u>Value of Crops Sold (\$)</u>	<u>Value of Livestock and Livestock Products Sold (\$)</u>
1944	5,201	607,192	4,886,753	16,894,607
1949	4,665	554,834	7,274,373*	15,916,295*
1954	4,311	580,680	7,602,760*	18,449,672*
1959	3,691	564,890	(not available)	(not available)

*Adjusted to the 1944 dollar value

Minerals

The tri-county area has deposits of petroleum, natural gas, stone, sand, and gravel. The importance of this production is illustrated by the dollar value in Table 3.

Table 3

Value of Mineral Production (1953-1959) 14/
(Figures in Millions of Dollars)

	<u>1953</u>	<u>1955</u>	<u>1957</u>	<u>1959</u>
Tri-county Area	3.0	4.4	7.2	10.1

The extraction of petroleum and natural gas has been responsible for over 80 per cent of the value of mineral production in the tri-county area. 15/

Manufacturing

Industrial activity is for the most part related directly to agriculture. In 1947, 11 of the 27 manufacturing establishments in this area were in the food and kindred products category; in 1954, 16 of the 37 manufacturing establishments were in this category. Employment figures further illustrate the industrial situation. In 1940, 46 per cent of the total manufacturing employment was in the food and kindred products category; in 1950, 47 per cent was in this category; and in 1960, it was estimated that 50 per cent was in this category. 16,18/

The tri-county area is relatively less industrialized than Kansas as a whole. According to the 1959 State employment figures, manufacturing employment was 7.4 per cent of employed workers in this area, as compared to 15.5 per cent for the entire State. 16,17/

Total manufacturing has increased since 1939, as measured by the number of employees and the value added by manufacture. See Table 4.

Table 4 16/Trends in Manufacturing

<u>Year</u>	<u>Number of Employees</u>	<u>Value Added by Manufacture (\$1,000)</u>
1939	203	
1947	635	701
		2,807
1954	866	
1958	1,229	(not available)
		7,033

Service Industries

Retail and wholesale trade, and all other service industries, account for the largest segment of total employment - about 67 per cent in the tri-county area in 1959. Since the statistical data exhibit no outstanding characteristics of this segment, details are omitted in this report.

Population

The population of the tri-county area has decreased 18.2 per cent from 1920 to 1960. During this period Emporia increased 84 per cent. Table 5 shows the historical population trends in the tri-county area. 8,9,10/

Table 5

Population Trends for the Tri-County Area and the City of Emporia, 1920-1960 8,9,10/

	<u>1920</u>	<u>1930</u>	<u>1940</u>	<u>1950</u>	<u>1960</u>
Emporia	11,273	14,067	13,188	15,669	18,190
Urban*	25,844	27,488	26,386	27,834	30,741
Rural	<u>30,377</u>	<u>29,443</u>	<u>25,334</u>	<u>19,880</u>	<u>15,251</u>
Total	56,221	56,931	51,720	47,714	45,992

*Urban includes Emporia and all other municipalities, regardless of size

Economic Outlook

This section defines the potential economy of the area. The tri-county area is adequately provided with the factors which permit economic growth. The area has good transportation facilities, an abundant supply of fuel and electric power, a surplus labor supply, and is readily accessible to large markets.

There is a promising outlook for agriculture in the tri-county area. The increasing national demand for livestock and livestock products indicates a likelihood for an increase in this category. The downward trend in agricultural employment is expected to level off and reverse slightly by the year 2015.

The extraction of petroleum and natural gas is expected to remain relatively stable. Petroleum geologists are confident that the tri-county area can continue its present rate of extraction over the next 50 years. An increase in employment is not expected in this category since the large fields are presently being worked to

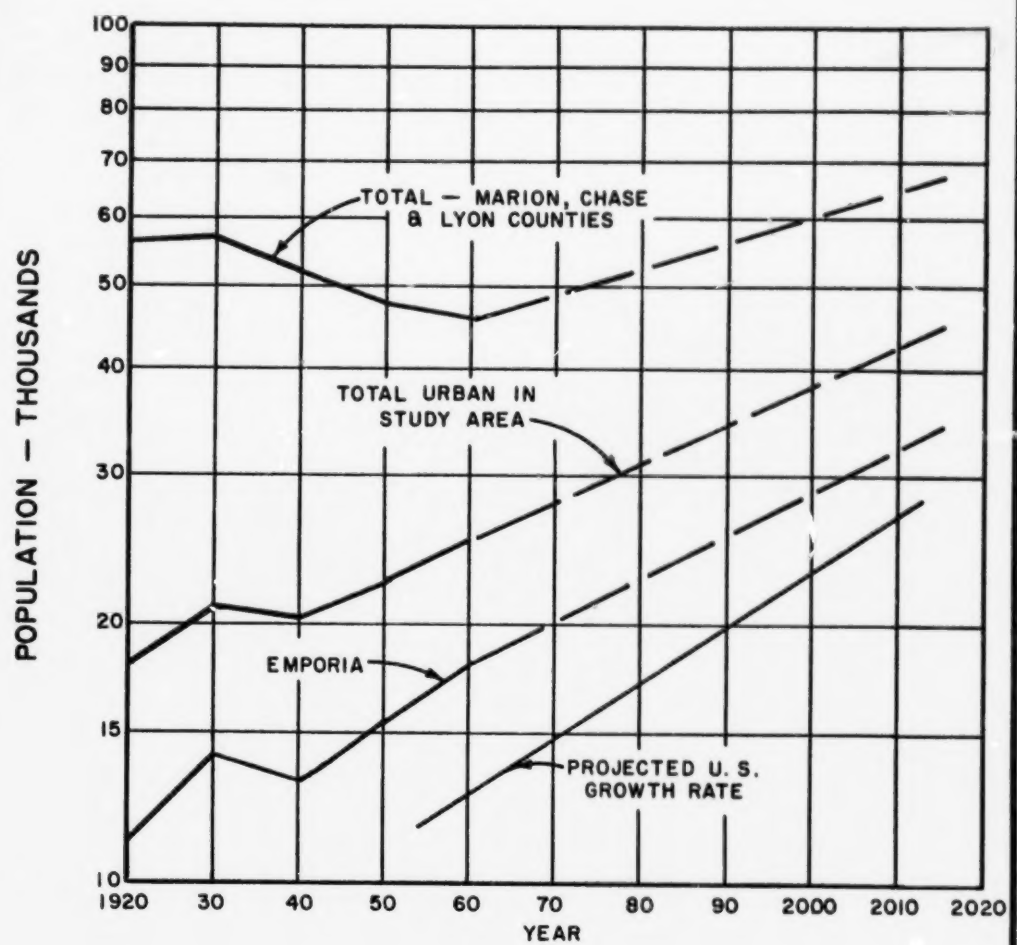
their maximum and pipelines are available to transport the raw products to the refineries at Wichita and McPherson, Kansas. 15/

With an increase of agricultural activity in the area, the number or the size of industries related to agricultural economy will probably increase. Feeder lots are expected to increase, as well as meat packing, chicken processing, milling, and soybean processing industries.

While emphasis has been placed on the use of agricultural products in manufacturing in the area, industry is not restricted to this field. However, the prospect for growth in the nonresource-oriented industries appears slight.

If the economic potential is developed to the fullest, the tri-county area is expected to reach a population of 68,000 by the year 2015. The principal segment of growth will probably be the city of Emporia, whose steady population growth is attributable to industrial and educational expansion. Assuming that this expansion continues, the population of Emporia is expected to reach 34,500 by 2015. The urban projection in Figure 2 is defined to include the cities of Emporia, Florence, Hillsboro, Marion, Cedar Point, Elmdale, Cottonwood Falls, and Strong City. The population of these cities which comprise the demand area is expected to reach 45,500 by 2015. See Figure 2.

Many factors were considered in formulating these projections. These are: past, present, and anticipated growth trends of the region; the past and present base of the particular place projected; and the economic and resource situation.



**MARION AND CEDAR POINT
RESERVOIRS**

POPULATION TRENDS

DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE

REGION VII DALLAS, TEXAS

FIGURE 2

VI. WATER SUPPLY AND DEMAND

Emporia

Emporia obtains its water from the Neosho River and its tributaries and from the Cottonwood River. The supply system consists of three small impounding reservoirs on the main stem of the Neosho River; one large impounding reservoir on Kahola Creek, a tributary of the Neosho; and a small reservoir on the Cottonwood River. ^{19/} The combined firm yield of these sources through a critical drouth period has been estimated by consulting engineers at 2.75 mgd. ^{19/} The dependable flow of the Neosho River will be increased upon completion of the Council Grove dam on the upper Neosho, now under construction by the Corps of Engineers. Conservation storage in Council Grove Reservoir is planned for low-flow augmentation at a minimum rate of 10 cfs (6.5 mgd) in the Neosho River at Emporia. Additional conservation storage, in an amount sufficient to yield 6 mgd, could be made available in Council Grove on a reimbursement basis, according to the Corps of Engineers. Officials of Emporia and Council Grove, Kansas, are currently negotiating for this storage space, each for half the yield.

The quality of water in both Neosho and Cottonwood Rivers at Emporia is satisfactory for general municipal and industrial use, Neosho water being somewhat better than Cottonwood. Typical analyses of Cottonwood River water were previously given in Table 1.

The record of past and present water usage at Emporia is given in Table 6, and the trend in per capita use of the last 20 years is shown on Figure 3. Annual rainfall at Emporia for the period 1949-60 is also plotted on Figure 3. This period includes the record drouth of the mid-fifties.

Highlight of the erratic pattern reflected in Figure 3 is the sharp decline in per capita water use in the ten-year period from 1947 to 1957. No single reason for this trend has been discovered. A part of the reduction has been explained by the change from steam to diesel locomotives by the Santa Fe Railroad. Emporia is a division point on the main transcontinental route of the Santa Fe, and was a watering point in the days of steam locomotion. The transition from steam to diesel, begun about 1940 and interrupted by the war, was virtually completed by about 1948. It is apparent, therefore, that reasons other than the steam-to-diesel transition must explain the subsequent reduction in water use.

Nevertheless, the Santa Fe Railroad was and is a major customer of the Emporia water department, for the railroad buys water for the operation of the cattle feeding lots, a major activity in Emporia. Water use by the Santa Fe was approximately 0.7 mgd during the years

immediately prior to World War II; reached a maximum of 1 mgd in 1944; declined to 0.7 mgd in 1952; dropped sharply to 0.4 mgd in the following year; and then to 0.1 mgd in 1954 and 1955. ^{19/} From city records, in 1960 the railroad purchased an average of 0.2 mgd, or about 11 per cent of the total water output.

Table 6

Historical Water Use at Emporia, Kansas

<u>Year</u>	<u>Average Water Pumpage* (mgd)</u>	<u>Estimated Population Served**</u>	<u>Gallons per Capita Day (gpcd)</u>
1940	2.13	13,200	161
1941	2.12	13,400	158
1942	2.31	13,600	170
1943	2.35	13,800	170
1944	2.50	14,100	177
1945	2.74	14,300	192
1946	2.84	14,600	194
1947	3.11	14,800	210
1948	2.96	15,100	196
1949	2.88	15,300	188
1950	2.62	15,700	167
1951	2.44	15,900	153
1952	2.65	16,200	164
1953	2.32	16,500	140
1954	1.70	16,700	102
1955	1.81	17,000	106
1956	1.87	17,200	109
1957	1.20	17,500	69
1958	1.59	17,700	90
1959	1.74	17,900	97
1960	1.88	18,200	103

*From city records

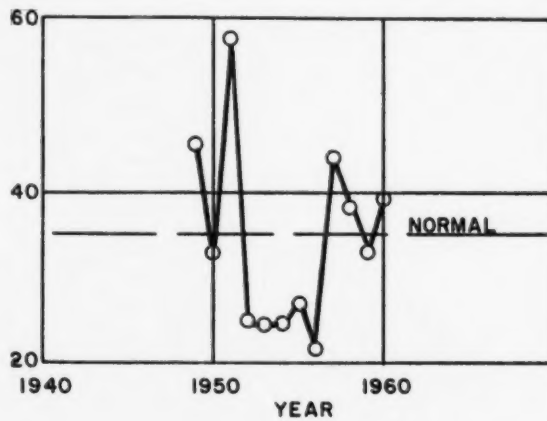
**Interpolated from U. S. Census data

There was a general shortage of water in the Neosho River valley in the drouth of 1952-57. The shortage of supply at Emporia, although not so acute as at its downstream neighboring city of Chanute, necessitated curtailment of water usage. This is probably the principal reason for the continuing decline in per capita consumption from 1952 to 1957.

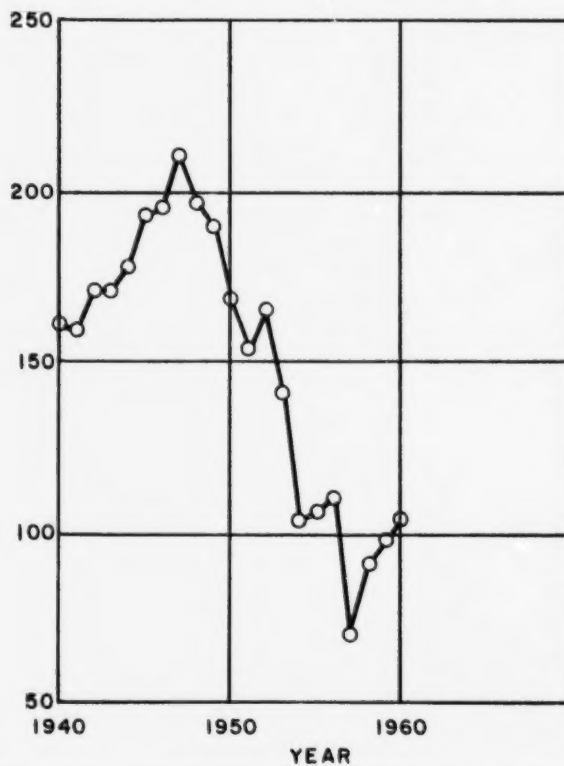
The estimated water demand for Emporia in the terminal year of projection, 2015, is 6.0 mgd. This represents the gross takeout

VI-2-a

ANNUAL RAINFALL - INCHES



GALLONS PER CAPITA DAY



MARION AND CEDAR POINT
RESERVOIRS
WATER USE AT
EMPORIA, KANSAS
DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

FIGURE 3

of water for both municipal and industrial purposes. It is based on a projected population of 34,500, and an assumed per capita demand of 175 gallons per day.

Hillsboro

"The Hillsboro municipal water supply is derived from 5 shallow drilled wells...located north and east of the city and from 3 shallow drilled wells...located at the southwest edge of town." 20/ The combined yield of seven active wells is reported to be about 0.7 mgd, with the eighth well available for use when needed.

The wells are not equipped with flow meters. Domestic and commercial consumption is metered at delivery; parks, public buildings, and city swimming pool are not. From the available records, it is estimated that total pumpage at present will average about 0.2 mgd. City officials state that no shortage of supply was experienced during the drouth.

It appears from the foregoing that the quantity of ground water at Hillsboro should be adequate to meet the future needs of a city of its size, with a reserve for normal growth. The quality of the ground water, however, leaves much to be desired. Examination of Table 7 will disclose that the water quality falls far below the recommended standards of the Public Health Service for drinking water. 5/

Of particular significance to water quality are those constituents which are both objectionable in high concentration, and not amenable to reduction by ordinary treatment methods. On that basis, the most seriously objectionable characteristic of Hillsboro ground water is the high concentration of sulfates (SO_4) and the resulting excess of total dissolved solids. Iron content is also high in the water, but this could be corrected by treatment. (The water receives no treatment except chlorination at present.)

There is no established maximum standard for hardness, but custom and prevailing opinion would indicate that hardness in the order of a thousand parts per million is much too high. This, too, can be reduced by treatment; however, the high proportion of non-carbonate (so-called permanent) hardness is noteworthy because of the relatively high cost of chemicals required in treatment.

The proximity of Marion Reservoir to Hillsboro makes it attractive as a possible source of supply to replace the present ground water, if there is assurance that the water will be of more desirable quality. As previously noted, a sampling program should be initiated to obtain more information about the quality of the surface water.

Table 7

Chemical Analyses - Ground Water*

Date	Sample From	Parts Per Million						Hardness	
		Total Solids	Fe	Mn	Mg	SO ₄	Cl	Total	Non-Carbonate
Hillsboro, Kansas:									
10-8-57	Well #2	2,249	0.30	0.00	78	1,328	61	1,653	1,357
10-8-57	Well #4	854	0.86	0.00	50	365	20	667	352
10-8-57	Well #5	816	1.0	0.00	51	343	14	646	328
10-8-57	Well #6	2,535	0.42	0.00	78	1,534	60	1,822	1,530
10-7-57	Well #9	2,355	1.6	0.07	123	1,465	20	1,768	1,462
10-7-57	Well #10	2,550	0.59	0.05	159	1,638	16	1,941	1,655
10-7-57	Well #11	2,438	1.7	0.11	142	1,554	14	1,846	1,560
10-8-57	Distri. System	2,134	0.17	0.00	77	1,249	58	1,552	1,254
10-8-57	Distri. System	2,040	0.26	0.00	52	1,187	58	1,584	1,284
4-26-60	City Reservoir	1,561	0.09	0.00	61	852	32	1,141	848
Cottonwood Falls:									
7-14-59	Well Coll. Line	373	0.32	1.9	27	47	9	298	10
8-29-60	Well Coll. Line	514	0.22	2.8	32	7	5	416	6
2-7-61	Well Coll. Line	497	0.16	2.4	38	58	7	430	22
Elmdale:									
6-27-60	Well	676	2.1	0.33	32	109	47	478	40
2-15-61	Well	645	0.91	0.25	35	101	40	476	42
Strong City:									
2-5-57	Plant (treated)	482	0.02	0.00	33	116	105	270	118
4-11-58	Well (untreated)	734	3.2	1.7	37	92	102	579	136
PHS Standard									
		500	(Fe + Mn: 0.3)	125	250	250	250	---	---

*Information from the files of Kansas State Board of Health

Marion

The city of Marion, Kansas, is also located close to the proposed Marion Reservoir. The current water usage of about 0.25 mgd is supplied from an impoundment on Mud Creek, a tributary of the Cottonwood River. Natural surface runoff into the existing reservoir is supplemented by pumping from a well located on the watershed. Maximum dependable yield of the source is unknown.

The limited available quality data ^{4/} suggest that water from the Mud Creek source, while not as bad as Hillsboro ground water, is somewhat high in sulfate content and hardness. Unfortunately, this information also adds to the suspicion as to the quality of water to be expected in Marion Reservoir, since the runoff is from the same general area for both reservoirs.

Other Communities

For the most part, the water needs of other communities in the study area are supplied from ground water. There are no major underground aquifers in the area; localized ground water occurs in shallow alluvial deposits. Although the yield from these wells is relatively small, it should be adequate to supply scattered small communities. Unlike the Hillsboro water, ground waters at other communities are generally of good quality, as exhibited in Table 7 for Cottonwood Falls, Emdale, and Strong City.

Need for Storage in Marion and Cedar Point Reservoirs

From the standpoint of inter-related problems of water supply and stream quality maintenance, Emporia is the focal point of the Cottonwood and upper Neosho River valleys. It has been shown that existing sources plus Council Grove Reservoir can provide combined flows exceeding the projected demand for municipal and industrial water at Emporia. But complete water resource planning demands that attention be given to the stream quality problems which accompany the use of water.

Especially in the Neosho Valley, proper water utilization requires that measures be taken to insure that waters, once withdrawn from the streams and returned, be reclaimed and restored to a quality that will permit reuse downstream. The use of water will almost inevitably result in the production of some liquid wastes which, even after a high degree of treatment, will degrade the quality of the receiving stream. It is essential that recognition be given to the need for flows which must be maintained in the receiving stream if the quality of its waters is to be kept at reasonable levels. Water to meet these stream flow needs is considered to be an inseparable part of the water demand on a system of reservoirs.

Areawide studies of the Neosho River and its tributaries have been made and reported by the Public Health Service in 1940, in 1952, and in August 1960. ^{6/} Reference is made to the latter report for supplementary details which will be omitted herein. That report and its predecessors considered the Marion and Cedar Point Reservoirs as part of a system of four reservoirs, the other two being Council Grove on the headwaters of the Neosho River, and John Redmond on the Neosho some 20 miles downstream from Emporia.

In the 1952 report, the Public Health Service recommended provision of storage, in projects located upstream from Emporia, to maintain an aggregate average firm flow at Emporia of 50 cfs. The review report prepared in 1960 reaffirmed the desirability of maintaining flows of that magnitude, for the dual purpose of meeting municipal and industrial water demands and of providing dilution water in receiving streams, as the final step in treated-waste disposal.

More detailed study of the history of past water use, coupled with a change in thinking as to the general trend of future water demands, has led to a minor downward revision of the projected municipal and industrial water demands at Emporia. Nevertheless, 50 cfs has been retained as the ideal objective flow for purposes of evaluation of storage. There are two principal reasons for this decision.

The first is the approximate nature of projection and calculation procedures; any significant change in the projected rate of growth, patterns of water use, types of industrial waste, or techniques of standard waste treatment, could alter the numerical answers.

The second reason is the limited capability of the projects under study to meet fully the water demands which may develop in the area in the next 50 years. For purposes of economic justification of the projects, it should be sufficient to show that the demand for water will be at least as great as the reservoirs can feasibly supply.

It is currently estimated by the Corps of Engineers that the authorized conservation storage volumes of Marion and Cedar Point Reservoirs combined would provide a firm flow of about 17 cfs at Emporia. As previously mentioned, this might be increased about 6 cfs by additional storage at Marion, although at higher unit cost. This, together with an estimated 10 cfs from Council Grove Reservoir on the Neosho and the regulation afforded by local impoundments of the city of Emporia, would still fall short of the objective of 50 cfs.

It is therefore concluded that the maximum economically feasible amount of conservation storage should be provided in Marion and Cedar Point Reservoirs.

VII. VALUE OF STORAGE

The underlying philosophy of the method adopted for monetary evaluation in this report is expressed in the following quotation from the Corps of Engineers manual EM 1165-2-105, dated September 7, 1960. 21/

"The benefits from municipal and industrial water supply storage result from improvements in conditions of water use, largely in regard to quantity and dependability, quality, and physical convenience. In basic concept the limiting values of such improvements are the maximum amounts prudent users would be willing to pay for the water supply storage components of municipal and industrial water supplies, assuming that decision would be made on the basis of a broad public viewpoint rather than a regional or local viewpoint. However, because of the complex objective and subjective considerations involved in the establishment of these maximum amounts, precise measurement of benefits on this basis frequently is difficult, if not impossible. Pending improvements in evaluation techniques, alternative costs comprise a conservative and the most generally acceptable basis for measurement of the benefits from municipal and industrial water supply storage."

On the Neosho and Cottonwood Rivers, the thought expressed in the above quotation is considered to apply not only to storage of first-use municipal and industrial water, but also to additional storage of water required to protect stream quality, by increasing the assimilative capacity of the stream for treated waste return flows which will aid in restoring receiving waters to a condition acceptable for downstream reuse.

The 1960 report on the Neosho River 6/ contains a discussion of the various alternatives considered, the alternative selected as a measure of monetary benefits, and the reasons therefor. As stated in that report, the annual value of storage was estimated at \$13,760 per cfs of yield, valid for any combination of storage amounts and yields up to a maximum of 50 cfs.

It is therefore recommended that monetary benefits from storage, for water supply and pollution abatement purposes in Marion and Cedar Point Reservoirs, be estimated on the basis of \$13,760 per year per cfs of firm yield. For a combined yield of 17 cfs, this is equivalent to \$233,900 per year. If additional storage is provided to increase the yield to 23 cfs, the estimated annual value will be \$316,500.

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